

Space Weather Technical Forecast

Issued on Thursday, 27 July 2023 at 01:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: R1/R2 radio blackouts likely. Chance of Active fluence later in the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-flares, the largest of which was an M4.6 from AR3376 at 26/1037 UTC. There are currently eleven sunspot regions on the visible disc, with AR3373 no longer visible on the west limb, but a new region rotating onto the northeast limb. AR3376 in the northwest has becoming increasingly active, but is very difficult to analyse due to the foreshortening effects near the western limb. AR3386 in the northeast is showing more area and spots as it rotates further onto the disc. Other regions appear to be stable at the present time. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, showed waning CME effects after a CME arrival at 25/2153 UTC, perhaps with some High Speed Stream (HSS) influence from CH28. Wind speeds varied mainly between 450-550 km/s, but jumped after 26/1600UTC to be between 520-580 km/s. Density was mostly average. The IMF was initially moderate, peaking at 14 nT, but slowly became weak. The north-south component was mostly southward directed, varying moderately at first then gradually varying weakly during the period. Phi angle was negative (towards the Sun), but switched to positive (away from the Sun) around 26/1600 UTC. Geomagnetic activity was Quiet to Active (Kp 2-4).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was very slightly elevated after a far-side event on 24 July, well below the S1 Minor Storm threshold, but gradually eased to background levels. GOES16 high energy (greater than 2MeV) electron flux was background to moderate throughout. The associated 24-hour integrated fluence was well below the Active threshold on a steady trend. Fluence was 5.28e6 integrated pfu at 27/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a slight chance of X-flares, most likely from AR3376.

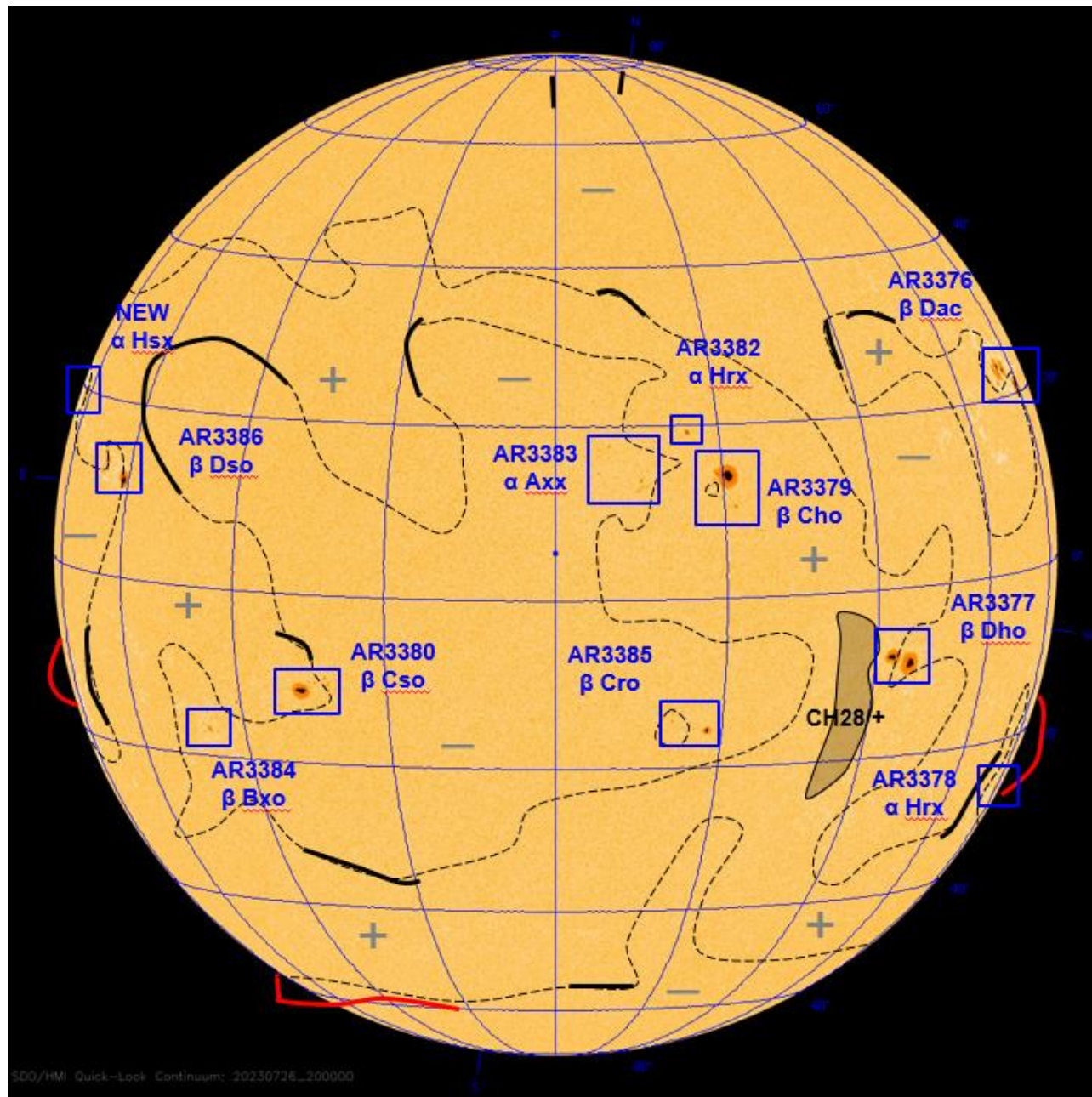
Solar Wind / Geomagnetic Activity: A CME arrived at L1 at 25/2153 UTC, which is now considered likely to have been the early arrival of a CME which left the Sun on 23 July. There are no further CME arrivals expected at the current time. A coronal hole HSS from CH28/+ may have already connected with Earth, although the ongoing weak CME effects are somewhat masking this signal. Wind speeds are likely to be elevated through the first couple of days of this period, with a slow decline expected thereafter.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, perhaps with some Active intervals on Days 1 and 2 (27-28 July) due to a combination of waning CME effects and a weak HSS.

Energetic Particles / Solar Radiation: There remains a slight chance of the high energy (greater than 10MeV) proton flux increasing from any further significant flares that occur. This
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

risk reduces a little through the period as AR3376 rotates away from the west limb. The high energy (greater than 2MeV) electron flux is likely to rise as wind speeds ease, with a chance of the associated fluence reaching Active (1e8 integrated pfu) levels later in the period.

Figure 1. Solar Analysis Valid 26/2000 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME arrived at L1 at 25/2153 UTC which is now considered likely to have been the early arrival of a CME which left the Sun on 23 July. This was forecast to arrive either later 26 July or during 27 July, but may have been faster than originally forecast. Therefore, there are no further CME arrivals expected at the current time.

A coronal hole HSS from CH28/+ may have already connected with Earth, although the ongoing weak CME effects are somewhat masking this signal. Alternatively, it may be yet to arrive within the next 24 hours or so. Wind speeds are likely to be elevated through the first couple of days of this period, with a slow decline expected thereafter.

Geomagnetic activity is expected to be mostly Quiet to Unsettled, perhaps with some Active intervals on Days 1 and 2 (27-28 July) due to a combination of waning CME effects and a weak HSS.

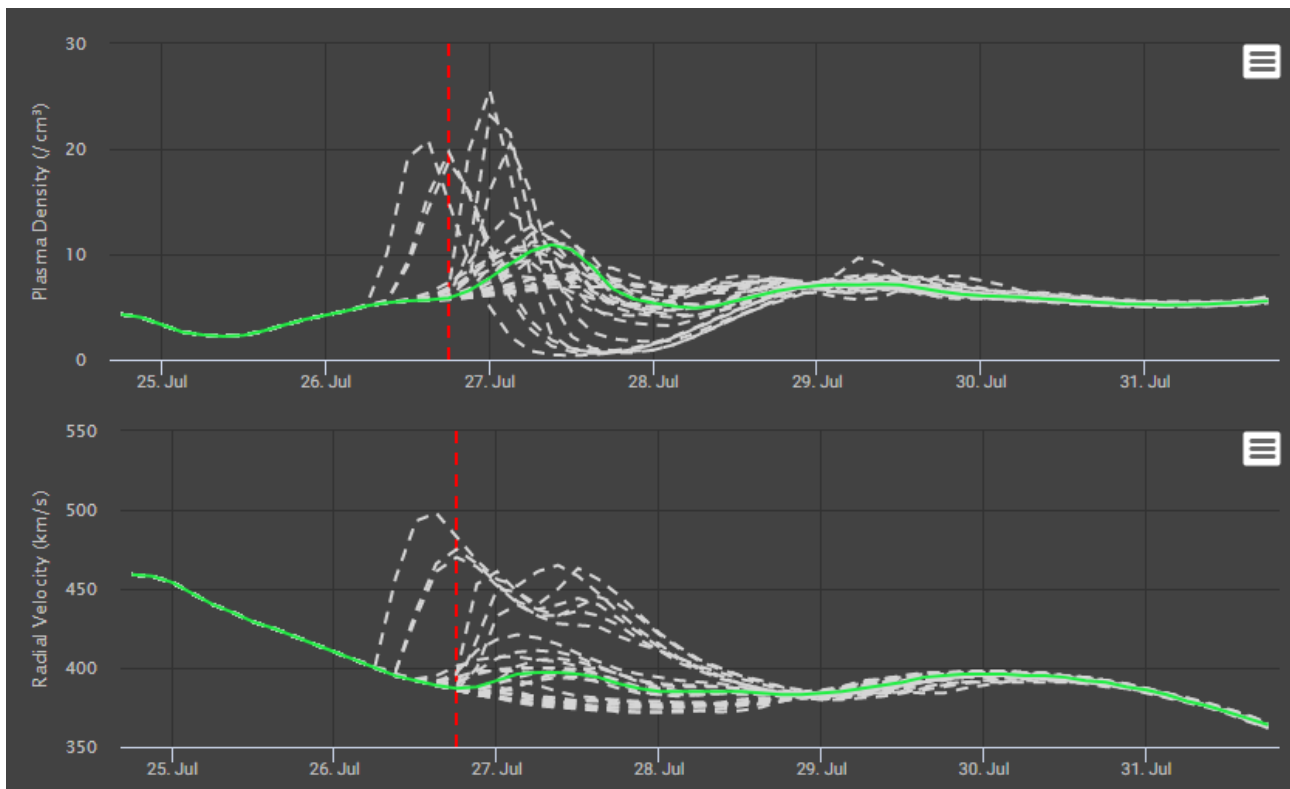
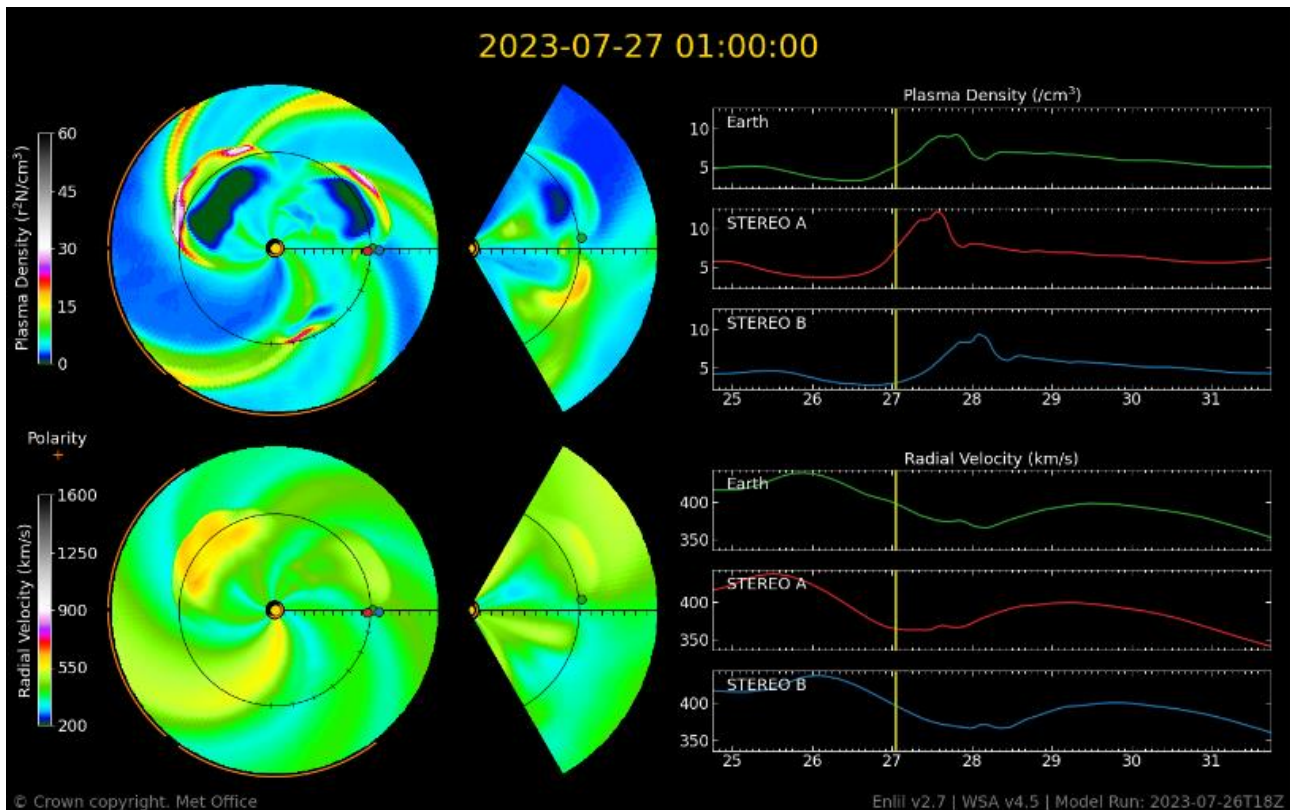
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth directed CMEs are currently expected.



Figure 2: MOSWOC Enlil and ensemble is still showing a likely CME arrival around 27/0000 UTC, but this is the CME that is considered most likely to have arrived early (late on 25 July).



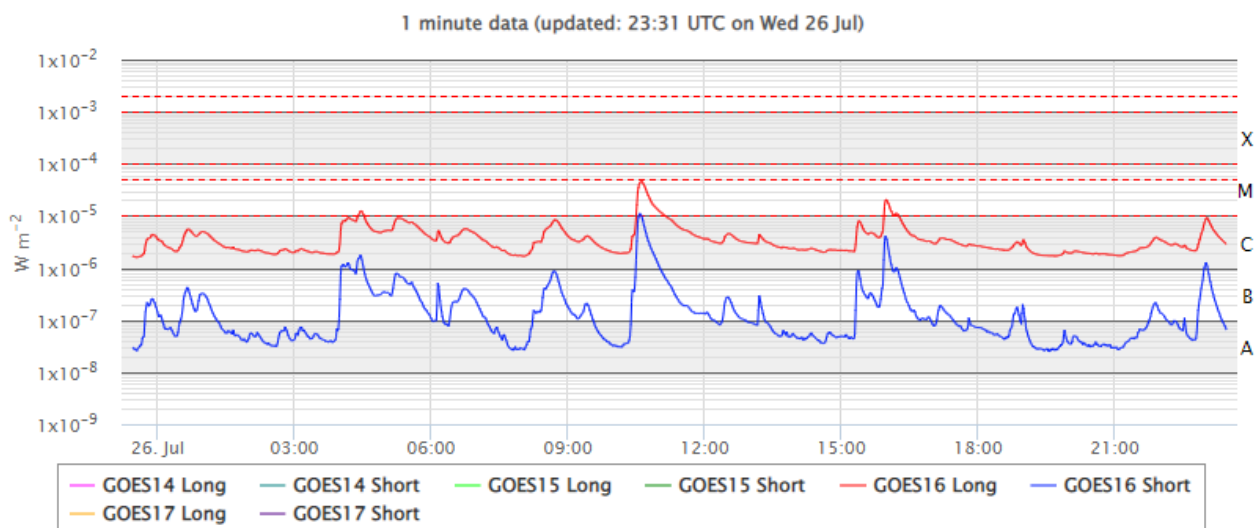
Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate over the past 24 hours with a peak flare of M4.6 observed from AR3376 at 26/1037 UTC. There are currently eleven sunspot regions on the visible disc, with AR3373 no longer visible on the west limb, but a new region rotating onto the northeast limb. AR3376 in the northwest has becoming increasingly active, but is very difficult to analyse due to the foreshortening effects near the western limb. Its classification will be maintained as it rotates off. AR3386 in the northeast is showing more area and spots as it rotates further onto the disc. Other regions appear to be stable at the present time.

Low to Moderate solar activity is expected, with a slight chance of X-class flares. Activity is expected to reduce somewhat as AR3376 rotates off the west limb by the end of Day 1 (27 July). Further regions are expected to rotate on however, although it is not possible to assess their likely level of activity until they become visible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: X-ray trace at GOES16, showing three M-flares in the last 24 hours.



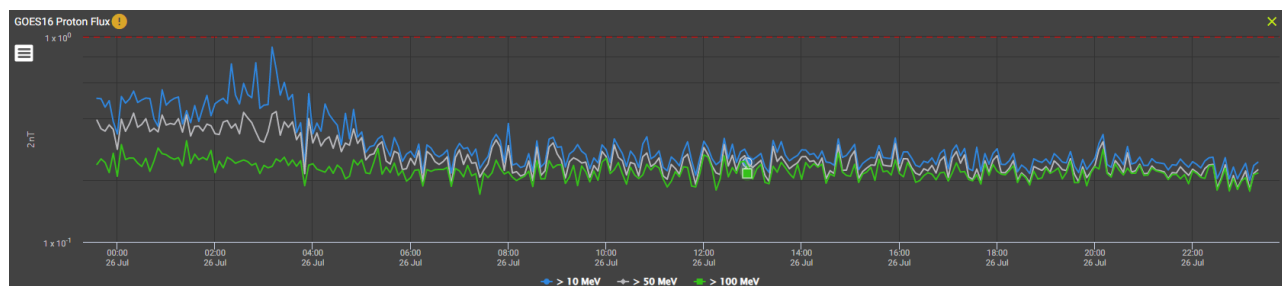
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 became enhanced on 24 Jul below the S1 level, due to a large far-sided eruption, but this has now declined to background. There is a slight chance of further enhancements given any large flares, primarily from AR3376 or any of the other regions on the western disc. The probability reduces through the period as AR3376 rotates well away from the west limb.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: Proton flux at GOES16 showing levels slightly raised early in the period (well below S1) declining to background.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy (greater than 2MeV) electrons reached moderate levels at the diurnal maximum. The recent CME arrival and possible HSS connection may be increasing the electron flux in the radiation belt, with the BAS radiation belt model suggesting an increase has taken place below GEO. As wind speeds wane during this period, an increase in electron flux is likely, perhaps sufficient to allow the electron counts at GEO to reach high levels.

Electron fluence is currently steady well below the Active ($1\text{e}8$ integrated pfu) threshold. If, as expected, electron flux increases through this period then fluence is also likely to follow a rising trend, with a chance of reaching Active later in the period. MOSWOC REFM is forecasting a rising trend just below Active, which seems like a reasonable guide, although confidence in the timing and magnitude of any rise is low.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	10	20	30	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM showing a forecast increase in fluence just below Active.

